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Lameness and Associated Risk Factors in Cart Mules in Northwestern Ethiopia

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Abstract: A cross sectional study has been conducted to determine the prevalence of lameness and associated risk factors in cart mules working in and around Adet Town, Yilmana Densa District, West Gojam Zone, Amhara Region, National Regional State from October 2013 to April 2014. A total of 390 cart mules along with their owners/drivers were randomly selected. Mules were physically examined for presence of lameness while cart mule owners were interviewed regarding their practice of mule management. An overall prevalence of 16.7% (n=65) lameness was recorded. Body condition score (BCS) of the mule, limb and hoof abnormalities, presence of free day within a week, condition of the cart and experience of the drivers were significantly associated with lameness among cart mules. There was no any statistically significant association of lameness with age and sex of study animals, length of trip covered, load weight transported at a time and availability of rest within a day, age and educational status of cart drivers. In conclusion, the result of this study showed lameness as a welfare problem for cart mules in the study area urging the need for improvement interventions through extensive awareness creation for cart mule owners and drivers, participatory harness and cart improvement schemes and even further detailed researches having wider scope.

Key words: Adet Town · Cart Mules · Lameness · Prevalence · Risk Factors

INTRODUCTION

An estimated 39 million donkeys, 40.5 million horses and 12.3 million mules live in developing countries, constituting over 85% of the world's equids [1]. Ethiopia possesses approximately half of Africa's equine population with 37%, 58% and 46% of all African donkeys, horses and mules, respectively [2]. There are about 1.96 million horses, 6.4 million donkeys and 0.37 million mules in the sedentary areas of the country. Donkeys and mules are extensively used, particularly in the rural socio economics. Amhara region is a home for about 2 million donkeys, 124 thousand mules and 300 thousand horses [3].

Over half the world's population depends on animal traction for its energy supply and, despite decreasing number of working equids in developed countries over the past century; numbers in many developing countries continue to grow [4]. Even in the 21st century an estimated 50% of the world's population depends on animal power as its main source of energy. In the developing world, threats to the welfare and productivity of working equids are substantial and the economic effects of health problems to these equids can be catastrophic to individual families [5].

Horses are transport animals, used for riding and for rural and urban transport. Other important work animals include mules that are mainly used in the hilly areas, for packing and riding, as well as in flatter rural and urban for pulling carts. Donkeys are mainly used to breed mules and light transport in the mountains [6].

Mules are specialized work animals produced by crossing a female horse with a male donkey. They are therefore only found where both horses and donkeys breed well, notably in temperate, semi-arid high-land areas. They make excellent, single-purpose work animals,

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being hardier than horses and stronger than donkeys. The great disadvantage of mules is that they are not fertile; so female horses have to be kept around to produce baby mules. This makes mules rather ex-pensive [7].

Mules are mainly used in hilly areas, for packing and riding, as well as in flatter rural and urban for pulling cart [6] playing an important role in rural communities providing power and transport at low cost. They can be used for various agricultural operations such as ploughing, transport for activities such as carrying water, building material, agricultural products and people. The efficient use of working animals depends on how they are connected to the implement they are pulling or the materials they are carrying and how well they have been trained and are managed [8].

In Ethiopia, The use of equines for transportation will continue for years to come because of the rugged terrain characteristics inaccessible for modern road transportation facilities as well as the absence of well-developed modern transport networks and the prevailing low economic status of the community. Therefore, the health and welfare of equines should be of crucial importance to Ethiopia [2].

Among welfare problems that affect working mule include lameness which is a departure from the normal stance or gait resulting from a structural or functional disorder of one or more limbs or the trunk. Lameness is not a disease but an indication of pain, weakness, or other impediment in the musculoskeletal system [9]. Clinical abnormalities associated with lameness and pain in working equids are diverse, prevalent and severe [10]; however, studies focusing on epidemiology of lameness in working mules are limited [11], which is the case in Yilmana Densa District. Therefore, the current study will investigate the epidemiology (prevalence) of lameness and associated risk factors on cart pulling mules in and around Adet Town, Yilmana Densa district.

MATERIALS AND METHODS

Study Area: The study was conducted from October 2013 to April 2014 on randomly selected working mules in and around Adet town (Administrative town of Yilmana-Densa Woreda, Amhara National Regional State, North-Western part of Ethiopia). The area is located at a distance of 565km from Addis Ababa. Yilmana-Densa is one of the districts in West Gojam Zone, Amhara National Regional state of Ethiopia. Yilmana-Densa is bordered on the south by Kuarit, on the southwest by Sekela, on the west by Mecha, on the north by Bahir Dar Zuria, on the east by the Abay River which separates it from South Gondar Zone and on the southeast by the East Gojam Zone.

The area is located at altitude ranging from 1552 to 3535m asl. The average annual rain fall is 1270mm with the main rainy season, from May to October. The agro-climatic zone comprises lowland (12%), mid highland (64%) and highland (24%). It has a temperature range of about 10ºC - 30ºC. The farming system in the area is mixed type (crop-livestock production). The livestock population of the area is estimated to be bovine 123,220, ovine 106,211, caprine 15,772, equine22, 886 and poultry 581,778 [12].

Study Population: The study was conducted on 390 cart puling mules and their drivers found in Adet town and surrounding Kebeles in Yilmana Densa district. The mules were selected on 16 villages of Yilmana Densa district namely Adet town, Gosheye, Shenkegna, Debremawi, Dambash, Mosebo, Kelelt, Densa Bata, Aybar, Konch, Tseone, Ayketuba, Kudad, Abeka, Ambatena, Ageta, Koker and Adet Hana.

Study Design and Methodology: A cross sectional study has been conducted to determine the prevalence of lameness and associated risk factors on cart mules working in Adet Town.

Sample Size Determination and Sampling Technique: A total of 384 cart pulling mules have been sampled randomly from their common collection area and market place in Adet town and nearby surrounding Kebeles. The sample size required was determined by the formula stated by Thrusfield [13] using 95% confidence interval, 5% of absolute precision and expected prevalence of 50% as follows;

$$N=1.96^2 P_{exp} (1-P_{exp})/d^2$$

where!

N= required sample size
P exp= expected prevalence
d= desired precision
Z = 1.96 for 95% confidence interval.
$n = 1.96^2\ 0.5(1-0.5)/0.05^2 = 3.84\times\ 0.25/0.0025 = 384$
n=384

Physical Clinical Examination for Lameness: Each randomly selected cart pulling mule has been carefully observed for any lame signs while in standing position and in motion. Further examination through palpation and of the limb and testing and manipulation of hoof area for any injury and deformity has been performed as described by American Association of Equine Practitioners guide. History from each owner has been accounted as important input for the examination. Lameness grading has been performed on a 0 to 5 scale by adapting the method from American Association of Equine Practitioners (AAEP) system.

Age, sex and BCS of the mule, limb examination for lameness, grade of lameness, observation for harness and others have been carefully recorded on a structured record format. Age and body condition score estimations have been made according to the method described by Svendsen [14].

Observation on Harnessing: Each cart that is associated with randomly selected mule has been observed for any ill-designs and problems with its parts like; unequal sized and deflated tyers, unbalanced shaft, heaviness and other harnessing problems.

Questionnaire Survey: A semi structured questionnaire has been used to collect information relevant to the prevalence of lameness and associated risk factors such as age, sex, experience and educational level of the driver, cart mule use and contribution, working nature and husbandry practices was recorded.

Data Management and Analysis: Data for both physical examination and questionnaire survey have been carefully coded and entered into Microsoft Excel-2007 spread sheet. The data was filtered for any invalid entry and then transferred to SPSS 16.0 version for windows package (2007) for statistical analysis. Analysis includes descriptive statistics and Pearson's Chi-square (x^2) Test was used to evaluate the relationship of different variables. Probability level of < 0.05 has been considered significant.

RESULTS

Demographic Data: Composition (characteristics) of study animals and their owners is illustrated in Tables 1 and 2 below.

Prevalence of lameness among age, sex and body condition of study mules: Prevalence of lameness among age, sex and BCS groups is summarized in Table 3 and 4.

From the total 390 physically examined mules 16.7% (n=65) were apparently lame. Lameness was significantly associated with body condition score (x^2= 13.576, $P < 0.05$). Those mules having BCS less than 3 (below average) were about 3-times at a greater risk of developing lameness (24.3%, OR = 2.786, CI = 1.593-4.873) than those mules having a good body condition (BCS greater or equal to 3) (10.3%, n=22) (Table 5). There was no any significant difference in the prevalence of lameness among age and sex groups ($P > 0.05$).

Table 1: Cart mule owners' age, educational status and work experience in Adet town and its surrounding. (n = 390)

Detail of cart mule owner		Frequency (n)	Percentage (%)
Age (In years)	< 20 years	70	17.9
	20 - 40 years	286	73.3
	> 40 years	34	8.7
Education	Illiterate	203	52.1
	Only read/write	52	13.3
	Elementary	95	24.4
	High school complete	40	10.3
Work experience (In years)	< 2 years	180	46.2
	> 2 years	210	53.8

Table 2: Age, Sex and body condition score of cart mules in Adet town and its surrounding. (n = 390)

Variable		Number, n (%)
Sex	Female	168 (43.1)
	Male	222 (56.9)
Age	5 -10 years	106 (27.2)
	10 -15 years	184 (47.2)
	> 15 years	100 (25.6)
BCS	<3	177 (45.4)
	>3	213 (54.6)

Table 3: Prevalence of lameness among age and sex groups of physically examined mules

Variable		No. of examined mules (n)	Lame cases (n)	Percentage (%)	Chi-square value	P – Value
Age (in years)	5-10	106	15	14.2	1.418	0.492
	10-15	184	35	19.0		
	>15	100	15	15.0		
Sex	Male	222	44	19.8	3.689	0.055
	Female	168	21	12.5		

Table 4: Prevalence of lameness among BCS groups

BCS category	No. of examined mules (n)	Lame cases (n)	Percentage (%)	OR (95% CI)
BCS < 3	177	43	24.3	2.786 (1.593-4.873)
BCS > 3	213	22	10.3	
Total	390	65	34.6	

CI = Confidence Interval; Chi-square = 13.574, P<0.05

Table 5: Prevalence of lameness and limb/hoof abnormalities

Limb abnormality	No. of examined mules (n)	Lame cases (n)	Percentage (%)
Posture/gait abnormality	3	1	33.3
Hoof overgrowth/deformity	47	15	31.9
Hoof cracking/chaffing	21	1	4.8
Stone	47	8	17.0
Posture/gait abnormality +hoof over growth/deformity + stone	6	4	66.7
Hoof over growth + stone and sole puncture	24	17	70.8
Hoof over growth + stone	21	15	71.4
Limb fracture	3	3	100.0

$F = 48.192$, P<0.05

Table 6: Prevalence of lameness by availability of free day within a week

Status of rest within a week	No. of examined mules (n)	Lame cases (n)	Percentage (%)	OR (95% CI)
Having rest	274	34	12.4	2.574(1.491-4.444)
No rest (work 7 days/ week)	116	31	26.7	
Total	390	65	39.1	

CI = Confidence Interval; Chi-square = 12.025, P<0.05

Limb abnormalities identified and lameness: From Figure 1 it has been indicated that from the total 390 mules examined 44.1% (n=172) showed variety of limb or hoof abnormalities. The most common limb and hoof abnormalities found were hoof over growth with deformity (12%, n=47) and presence of stone inside sole (12%, n=47). The rest 55.9% (n=218) showed no limb or hoof abnormalities.

Limb and hoof abnormalities were significantly associated with the prevalence of lameness ($F = 48.192$, $P < 0.05$). All of the limb fractures (n=3) observed have caused lameness on mules. Concurrence of hoof over growth plus stone was found to cause 71.4% (n=15) of lameness cases. Seventy one percent (n=17) and 66.7% (n=4) of lame cases were due to the combine effect of hoof overgrowth plus hoof puncture (stone) and gait abnormality plus hoof over growth with stone respectively (Table 6).

Lameness Grades: Out of the 65 lameness cases, majority of them (50.8%, n=33) were apparent while mules were walking without carrying any load (Grade 4) and 36.9% (n=24) of the cases were apparent while only mules were working carrying load (Grade 2) (Figure 2).

As illustrated in Figure 3, significant number of lame mules with BCS of less than 3 (62.8%, n=27) were with grade 4 lameness than those with good BCS (27%, n=6). Significant number of those lame mules (63.6%, n=14) having good BCS were with grade two lameness.

Association Between Lameness and Working Nature of Cart Mules: There was significant association between overall lameness prevalence and availability of free day within a week ($x2= 12.025$, $P < 0.05$). Cart mules having no any free day within a week were2.6-times at a greater risk (26.7%, OR = 2.574, CI = 1.49- 4.44) for lameness than those having free day (12.4%) (Table 7).

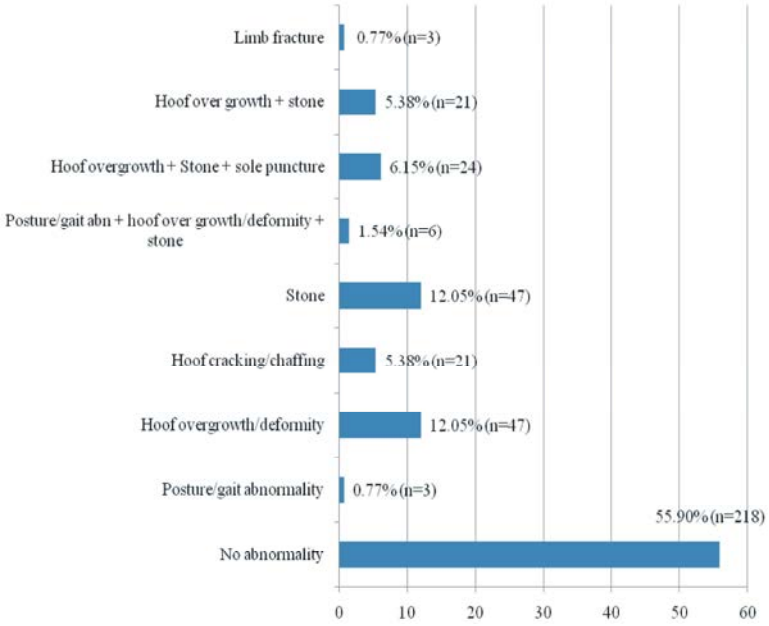

Fig. 1: Limb examination findings of cart mules in Adet town and its surrounding (n = 390).

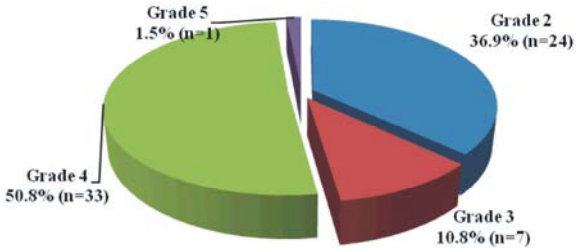

Fig. 2: Proportion of lameness grades identified (n = 65).

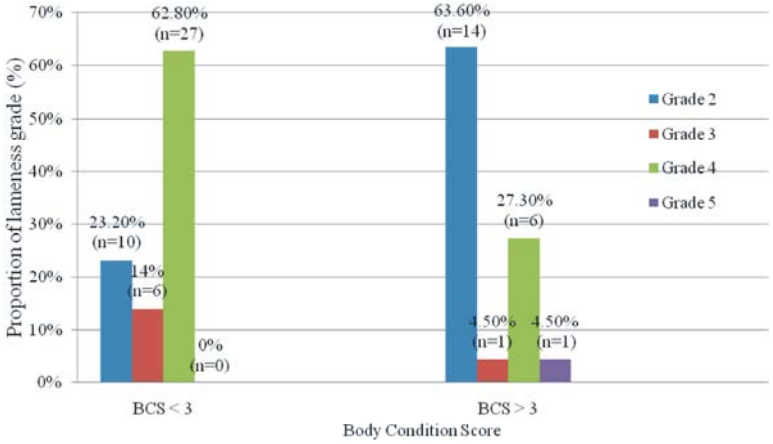

Fig. 3: Severity of lameness among body condition scores. $F = 12.501$, $P < 0.05$

Table 7: Prevalence of lameness by availability of rest within a day

Condition of rest within day	No. of examined mules (n)	Lame cases (n)	Percentage (%)	OR (95% CI)
Have rest	354	61	11.1	0.600(0.205-1.760)
Without rest	36	4	17.2	
Total	390	65	28.3	

CI = Confidence Interval; Chi-square = 0.881; P>0.05

Table 8: Prevalence of lameness by length of trip covered

Length of trip (in Kms)	No. of examined mules (n)	Lame cases (n)	Percentage (%)	OR (95% CI)
4-8 Kms	67	15	22.4	1.563(0.817-2.991)
More than 8 Kms	321	50	15.6	
Total	388	65	38.0	

CI = Confidence Interval, Chi-square = 0.881, P>0.05

Table 9: Prevalence of lameness by load weight transported ones

Load weight transported	Examined (n)	Lame cases (n)	Percentage (%)
<500 Kgs	237	32	13.5
500-1000 Kgs	150	33	22.0
1000-1500 Kgs	3	0	0.0
Total	390	65	35.5

F = 4.830, P>0.05

Table 10: Prevalence of lameness by cart condition

Cart condition	No. of examined mules (n)	Lame cases (n)	Percentage (%)	OR (95% CI)
Problem with cart (unequal sized tyre/shaft imbalance)	24	12	50.0	5.906(2.520-13.837)
No any problem with cart	366	53	14.5	
Total	390	65	64.5	

CI = Confidence Interval; Chi-square = 20.459, P<0.05

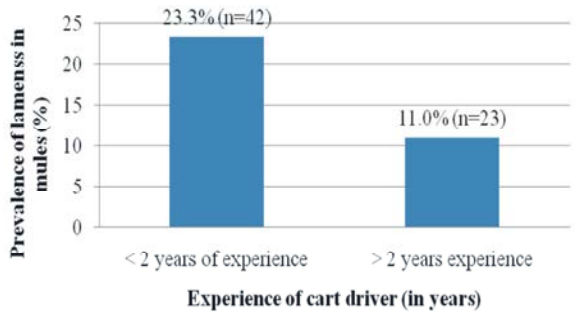

Fig. 4: Influence of experience of cart driver on lameness prevalence.
Chi-square = 10.697, P < 0.001, OR = 2.474, CI (1.422 – 4.306)

No any significant difference in the prevalence of lameness was observed among conditions of rest within a day (Table 8).

There was no any significant difference in the prevalence of lameness among length of trips covered ones and load of weight carried (Table 9 and 10).

Lameness and Harnessing: Cart condition was significantly associated with prevalence of lameness ($x2$= 20.459, P<0.05). Cart mules pulling carts having some sort of problem were 6-times at a greater risk (50.0%, OR = 5.906, CI = 2.520 - 13.837) of developing lameness than those mules attached with cart having no any problem (14.5%).

Lameness and Cart Mule Owners' (Drivers) Experience: Figure 4 above illustrates that the prevalence of lameness and experience of cart drivers were significantly associated ($x2$= 10.697, P<0.05). Lameness was highly prevalent on cart mules which are handled by drivers having experience of less than two years (23.3%) (n=42) than drivers with high experience (11%) (n=23).

DISCUSSION

In the current study the overall prevalence of lameness was 16.7%. This figure is much higher than the reported 3.1%prevalence in donkeys in Addis Ababa and Central Oromia region of Ethiopia [11] and it was found lower than the study reports by King *et al*. [15] and Naeini and Niak [16] in carriage horses in Yucatan, Mexico and Iran respectively and Reix *et al*. [17] (89%) in donkeys of Pakistan. The difference in prevalence might be due to variation in the study technique, time and place of study conducted, species of study animals; leg or joint problems were the most commonly perceived cause of lameness in the spring and winter with hoof problems the most common cause in summer [18].

Greater prevalence of lameness in mules with poor body condition has been a significant scenario in the current research. A similar finding has been reported by Shimeles [19] in horses in Adigrat and Broster *et al*. [10]. This could be due to the fact that in mules with poor body condition the skeleton parts are highly exposed to outside

and have great probability to be rubbed by harnessing materials resulting in injury possibly lameness if limbs are involved. Poor body condition results in musculoskeletal weakness and causes inability of mules to bear weight of the cart leading to lameness [20-21]. Alternatively, malnutrition [22] and/or overwork [23] could lower body condition and increase the chances of lameness simultaneously.

Kane *et al.* [18] and Broster *et al*. [10] reported that a higher lameness scores in older horses that young ones. Similarly, a study on the range and prevalence of clinical signs and conformation associated with lameness in working draught donkeys in Pakistan has showed a higher lameness scores in older donkeys than young ones [17]. But in the current study there was no any significant association between lameness and age of mules with age between 10-15 years were observed with greater frequency of lameness than those much older or young ones. It can be related to the age of maximum performance of mules, because in 6-8 years age group the growth of horse is completed.

Limb and hoof abnormalities were significantly associated with lameness. This finding is consistent with previous welfare assessments of equids done in Afghanistan, Egypt, India, Jordan and Pakistan, where limb-associated abnormalities were highly prevalent across all species, with 94.7% of working donkeys, 90.9% of working mules and 89.6% of working horses showing some degree of gait abnormality, ranging from mildly abnormal to severely lame [24]. A study of 58 draught equids (42 horses and 16 mules) carried out by Maranhão *et al*. [23] in Brazil reported high prevalence of multiple pathological abnormalities of limbs. This may be as a result of the geographical location of the area which comprises flat surfaces, hilly areas, rough roads and slippery surfaces.

In the current research cart mules which are continuously used without any day off in a week were significantly three times at risk of becoming lame than those having rest more than a couple of days. This might be due to the fact that all of the cart mule owners depend heavily on their animals for income generation, hence they use their mules without rest which might predispose them to lose their body condition and possibly to become lame. A report by Maranhão *et al*. [23] has indicated that over work on unstable surfaces result in prevalence of multiple joint and tendon swellings and reduced joint flexion, which are clinical signs of lameness.

There was a statistically significant association between condition of the cart and prevalence of lameness ($p<0.05$). This study revealed that mules with cart problems encountered lameness (50%) more frequently than mules without any problem on the cart (14.5%). This could be due to improper fitted saddle, unequal sized tyre and shaft imbalance. Reix *et al*. [17] had suggested that the weight of a cart could cause a caudal shift in the center of balance, potentially increasing the likelihood of hind limb lameness in draught animals.

Experience of the drivers was other variable which shows statically significant association with lameness prevalence in this study ($p<0.05$). The risk of developing lameness was about three times higher on cart riders having an experience of less than two years than those more experienced ones. Gonzalez *et al*. [25] stated that the probability of animals becoming non-ambulatory or totally compromised during transport was greater in drivers with 0 to 5 yr compared with 6 or more years of cattle hauling experience ($P< 0.01$). The proportion of totally compromised animals decreased

6-fold as the experience of truck drivers increased from <2 to >10 yr of cattle hauling experience.

Experienced drivers usually practice checking their mule's feet before and after work while inexperienced ones do it occasionally especially only when they notice lame signs.

Other independent variables which are not significant factors in this study include age and educational status of the cart mule owners/drivers, rest within working days, length of trip and load weight carried by carts. This could be due to the difference between socio-cultural and behavioral characteristics of the community in those studies and this study and the difference in methodology and the time gab between this study & some of those studies.

CONCLUSION

The current study has clearly presented the prevalence of lameness and its association with sets of risk factors in cart mules of Adet town and its surroundings. Hence, approximately 17 mules in every hundred have been observed to suffer from lameness which is among the well known welfare problems of equids. Hoof or limb abnormalities, poor body conditions, exhaustive and restless working nature of cart mules, poor harnessing or cart design and inexperience of cart drivers have been identified as possible predisposing and or causative factors for lameness in cart mules in the study area.

Recommendations: Awareness creation to cart mule owning community on proper management and handling of mules is important step to be taken. Animal welfare improvement programs should integrate harness development plans and provide trainings on how to properly use optimum working performance of mules. Further studies with wider scope are required as base line prior to designing improvement plans.

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